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FROM: Bill Johnson

DATE: September 12, 2005

SUBJECT: RESPONSES TO SCIENTIFIC PEER REVIEW COMMENTS—WATER QUALITY ATTAINMENT STRATEGY AND TMDL FOR DIAZINON AND PESTICIDE-RELATED TOXICITY IN BAY AREA URBAN CREEKS

In June 2005, we completed a draft Basin Plan amendment and supporting staff report for a water quality attainment strategy and total maximum daily load (TMDL) for diazinon and pesticide-related toxicity in Bay Area urban creeks. We provided copies to two scientific peer reviewers: Professor David Sedlak of the University of California, Berkeley, and Professor Allan Felsot of Washington State University, TriCities. The intent of the review was to ensure that the scientific portions of the proposed amendment are based on sound scientific knowledge, methods, and practices. Therefore, the reviewers' comments focus mainly on the scientific portions of the draft amendment and staff report. Our responses to their comments are below.

PROF. DAVID SEDLAK

Our responses to Prof. Sedlak's comments follow the numbering he uses for his comments.

1. Prof. Sedlak notes that Section 8, "Linkage Analysis," describes pyrethroid degradation rates in soil but not persistence in creek sediment, which may be important for pyrethroids because they bind well to sediment. With long half-lives in sediment, pyrethroids can build up before approaching a steady state. Considering the rising trends in pyrethroid use, pyrethroid concentrations may currently be increasing in sediment.

   Prof. Sedlak recommends that we add information from a recent study by Gan et al. (2005) and we have done so. Gan et al. report half-lives for two pyrethroids, bifenthrin and permethrin. At 20°C, bifenthrin's half-life in sediment ranged from 36 to 71 weeks. The median measurement was about 60 weeks. Permethrin's half-life in sediment ranged from 9 to 54 weeks. The median was about 30 weeks. At 4°C, the bifenthrin half-life ranged from 40 to 280 weeks, with a median of about 90 weeks. The permethrin half-life ranged from 21 to 310 weeks, with a median of about 30 weeks.

   Prof. Sedlak suggests giving priority to studies designed to monitor pyrethroid concentrations in sediment and to determine their degradation rates. He suggests tracking past trends in sediment pyrethroid concentrations, but we are unable to do so because we are unaware of any archived sediment samples. However, the monitoring program described in Section 11, "Monitoring and Adaptive Implementation," calls for monitoring pesticides (including many pyrethroids) that pose water quality threats in water and sediment. The same staff report section identifies critical data needs, which include studies that characterize the fate and transport of pesticides applied in urban areas. This critical need encompasses efforts to study pyrethroid degradation rates in creek sediment.

2. Prof. Sedlak expresses a desire for more evidence to justify concerns about pyrethroid toxicity, noting that Section 3, "Pesticide Use Trends," cites only unpublished data presented by Amweg et al. (2005). While he does not actually question the pyrethroid concerns, he does suggest that we contact Prof. Donald Weston to obtain additional data. We contacted Prof. Weston, but unfortunately, no more information is readily available at this time (Weston 2005). He states, "The 'big picture' has not changed, but the details have, and thus it may be a mistake to present the specifics…until the work is finalized and published." We revised our text somewhat based on his response.

   Prof. Sedlak suggests that the Water Board dedicate resources to obtain more data if data are unavailable. Some important data will be published soon. Prof. Weston expects to publish his Bay Area urban creek findings in about six months. He anticipates that the Sacramento area results will be available in about two months. Nevertheless, we agree that more monitoring will be needed, as described in Section 11, "Monitoring and Adaptive Implementation."

   Prof. Sedlak indicates that the text of Section 3, "Pesticide Use Trends," implies that, because toxicity exists in the Sacramento area, toxicity also exists in the Bay Area. However, we wish to clarify that the text merely refers to the Sacramento study for context. We do not assume that Bay Area conditions are the same as Sacramento area conditions. Sediment toxicity and pyrethroid concentrations have been measured in some Bay Area creeks in addition to the studies undertaken in the Sacramento area.

3. Prof. Sedlak notes that we described numerous early implementation activities (Section 12, "Early Implementation") but did not describe any measures of success for these activities. He recommends that we learn from these projects and ensure that future actions include mechanisms to measure success. In particular, he recommends collecting baseline creek data and conducting consumer behavior surveys before and after outreach. He suggests that efforts to change behaviors be coupled with programs designed to quantify the cost-effectiveness of such actions.

   Table 12.1 lists several pesticide-related State Water Board grants benefiting the Bay Area. Each grant includes a project assessment and evaluation plan, and the final report for each project will evaluate its success. We expect the resulting information to be useful in developing future projects. One of these grants, the Urban Pesticide Pollution Prevention (UP3) Project, also includes work with urban runoff management agencies to improve the effectiveness of their pesticide toxicity control plans. Additionally, the UP3 Project will develop and implement tools to measure outreach program effectiveness and provide recommendations to improve mitigation.

   In addition to assessing the success of these grants, we will evaluate future actions through adaptive implementation (Section 11, "Monitoring and Adaptive Implementation"). The Water

Board and urban runoff management agencies will continue to monitor urban creek conditions to ensure that implementation efforts are effective. Because urban creek pesticide concentrations vary substantially both in individual creeks and among creeks, measuring relatively small changes in response to specific implementation actions is difficult if not impossible. Surveying public attitudes and behavior is somewhat easier (although surveys are an indirect means of evaluating water quality threats). In 2003, the University of California Statewide Integrated Pest Management Program conducted a survey of Bay Area residents (UC IPM 2003). The survey provides a useful baseline for future surveys.

Assessing past mitigation successes (and failures) is an important part of designing cost-effective future mitigation. However, we believe pesticide-related outreach, by itself, is limited in its potential to change behaviors and water quality. Such outreach is, therefore, just one important component of our more far-reaching strategy, which calls on the U.S. Environmental Protection Agency, the California Department of Pesticide Regulation, and others to act in concert with the Water Board to ensure attainment of water quality standards. We hope outreach will reinforce such actions by increasing public interest in and acceptance of integrated pest management and less toxic pest control techniques, and by increasing public demand for and acceptance of appropriate solutions.

4. Prof. Sedlak recommends that Table 2.3 be revised to include a geometric mean or median in addition to the range of diazinon concentrations measured during the 1994-1995 wet season. Unfortunately, this table, which is taken directly from the cited source (SWRCB et al. 1997), lists only "selected" concentrations, not all concentrations. The median of the concentrations listed in the table is about 370 ng/l. However, we do not know what criteria were used to select these data (i.e., whether the data not selected for inclusion tended to be similar to the selected data), so this median may not be meaningful. The purpose of the table is simply to demonstrate that, at the time, relatively high diazinon concentrations could be found in urban creeks throughout the Bay Area. Therefore, we have not revised the text.

5. Prof. Sedlak points out that, as of 2003, agricultural diazinon uses comprise the greatest fraction (about 58%) of total reported Bay Area diazinon use. He wonders whether agricultural discharges could be a problem. As shown in Figure 3.2, however, agricultural diazinon use has been declining since 1995 (although not as quickly as other diazinon uses). Therefore, the importance of agricultural diazinon runoff has diminished over the last decade. We believe agricultural diazinon use in the Bay Area continues to be negligible. As explained in Section 3, "Pesticide Use Trends," the agricultural pesticide use reported for the nine Bay Area counties substantially overstates use within the Water Board's jurisdiction because most agricultural use in the nine counties occurs outside the Water Board's jurisdiction. In 2000, only 15% of reported agricultural diazinon use in the nine Bay Area counties occurred within the Water Board's jurisdiction. This was only about 3% of the diazinon use reported for the nine Bay Area counties and less than 2% of all reported and unreported diazinon use in the nine Bay Area counties that year (CDPR 2001a; CDPR 2004; ACFCWCD 1997). In terms of pesticides in general, by 2003, roughly 93% of the pesticides applied in the nine Bay Area counties were applied for urban purposes (TDC 2005). Only about 7% were applied for agricultural uses, and as explained above, most of this occurred outside the Water Board's jurisdiction.

While it is conceivable that local areas of creek watersheds could be sources of diazinon or pesticide-related toxicity due to agricultural pesticide applications, we view this as unlikely. We do not have any information showing that agricultural activities upstream from or within Bay Area urban watersheds cause or contribute to diazinon or pesticide-related toxicity in urban creeks. Nevertheless, the proposed Basin Plan amendment includes a provision through which the Water Board may recognize heretofore unidentified pesticide sources and assign the same allocations as proposed for storm drains. We do not, however, believe an agricultural control program is warranted at this time based on existing information.

6. Prof. Sedlak notes that we cited a generic sediment-water partition coefficient for pyrethroids based on Amweg et al. 2005 and suggests that we also refer to Gan et al. 2005. We revised Section 3, “Pesticide Use Trends,” to incorporate this information.

7. Prof. Sedlak questions whether 99% of malathion use can be attributed to over-the-counter use, as indicated in Table 6.1. We rechecked our figures and confirmed that, in 2003, only about 1% of malathion was applied by professionals. Therefore, homeowners apparently applied the rest. Of course, this number is somewhat uncertain (refer to the cited text [SFEP 2005]), and more importantly, malathion use varies from year to year. This total urban use estimate is based in large part on statewide sales data for one year scaled on the basis of the Bay Area population. In any case, not much urban malathion use is reported in the Bay Area, which means most of the malathion used is sold over-the-counter.

8. Prof. Sedlak notes that the volatility of pesticides applied to inert surfaces generally relates to vapor pressure, but the volatility of pesticides applied to soil or water is probably more closely related to Henry’s Law constants. We revised Table 8.1 to include Henry’s Law constants. When we were unable to find values in published literature, we estimated them by dividing vapor pressures by solubilities in water. As Prof. Sedlak suggests, many of the pyrethroids have higher Henry’s Law constants than diazinon and therefore may enter the atmosphere somewhat more readily from soil and water. Nevertheless, they would generally deposit nearby, just like diazinon.

9. Prof. Sedlak notes that a pesticide’s octanol-water partition coefficient (as opposed to its solubility) is normally used to predict particle-water partitioning. Aqueous solubility is often, but not necessarily, correlated. Table 8.1 contains octanol-water partition coefficients. We revised Section 8, “Linkage Analysis,” to clarify how these partition coefficients relate to the potential for pesticides to adhere to soil and sediment.

PROF. ALLAN FELSOT

Our responses to Prof. Felsot’s comments follow the headings he uses for his comments.

Introductory Comments

Prof. Felsot summarizes the strategy in his introductory remarks. To clarify some statements he makes, we note that water quality standards consist of water quality objectives, beneficial uses, and anti-degradation provisions. The proposed Basin Plan amendment includes numeric targets that interpret narrative objectives. We do not recommend adopting our proposed targets as water quality objectives. Therefore, if adopted, the targets would not themselves be considered water quality standards. In addition, the narrative objectives do not specify that Whole Effluent Toxicity tests be used to evaluate toxicity, but such tests are among the many tools at our disposal for evaluating attainment of the narrative objectives.

Comment on Numeric Targets

The Numerical Standard for Diazinon

Prof. Felsot confirms that the proposed diazinon target is reasonable and employs an independent line of reasoning to justify his conclusion. In his argument, he inadvertently misstates the current California Department of Fish and Game water quality criteria for diazinon. The acute and chronic criteria had been 80 ng/l and 50 ng/l (CDFG 2000), but the California Department of Fish and Game revised these values. They are now 160 ng/l and 100 ng/l (CDFG 2004). Therefore, whereas Prof. Felsot states that the proposed target is somewhat higher than the California Department of Fish and Game chronic criterion, it is, in fact, the same (although the averaging time is different). In any case, Prof. Felsot concludes that the proposed diazinon concentration target is protective of aquatic life.

The Toxic Units Criterion

Prof. Felsot posits that the Basin Plan's narrative objectives, in referring to "controllable water quality factors" and "no detrimental increase in the concentration of toxic pollutants," recognize that contaminants already exist in creeks and may imply that only pesticides in creeks are "controllable." This interpretation stretches the language of the Basin Plan beyond its intended meaning. "Controllable water quality factors" are those actions, conditions, or circumstances resulting from human activities that may influence water quality and may be reasonably controlled. In other words, some chemicals naturally present in creeks may potentially contribute to toxicity, but we cannot do anything about them. Potentially toxic pollutants resulting from human activities (e.g., most pesticides and many other pollutants) are controllable.

On the basis of Prof. Felsot's flawed interpretation, he concludes that the generic toxic unit approach we propose for numeric targets has some shortcomings. He notes that standard toxicity tests cannot distinguish pesticide-related toxicity from toxicity caused by other factors, and Toxicity Identification Evaluations may be needed to determine whether pesticides cause toxicity. We agree. Further analysis may be required to determine the extent to which observed toxicity is caused by pesticides or other pollutants. We discussed this practical consideration in Section 7, "Numeric Targets." However, we prefer our generic approach because the Basin Plan's narrative objectives are themselves generic. Toxicity incorporates the combined effects of chemical mixtures, and toxicity tests closely relate to the Basin Plan objectives. As we stated in Section 7, "Numeric Targets," when narrative objectives are not met in urban creeks, we need to determine the chemical cause of the toxicity. If the Basin Plan objectives are not met due to pesticide discharges, the proposed strategy applies. If the objectives are not met due to other factors, other actions to attain water quality standards are needed, but the proposed diazinon and pesticide-related toxicity strategy is not the appropriate vehicle to address the problem.

The concerns expressed regarding our generic approach are of little practical consequence for urban runoff management agencies and others monitoring water quality in urban creeks. Existing municipal urban runoff permits require dischargers to characterize their discharges and receiving waters. This generally involves monitoring for toxicity. When toxicity is found, the sources of the toxicity need to be identified and appropriate controls implemented, whether or not pesticides cause the toxicity.

Prof. Felsot states that chronic toxicity tests may be prone to relatively high false positive rates. In other words, chronic toxicity could be observed when no ecological effect is likely. This scenario is more desirable than the alternative (false negatives). False negatives could miss potential toxicity. Relying on a standard test that could produce some false positive results is a conservative approach and contributes a margin of safety to our strategy.

Prof. Felsot notes that quantifying toxic units requires dilution, and diluting sediment may be difficult. He is correct that there is no standard method for diluting sediment for purposes of toxicity tests. However, as he also notes, Amweg et al. (2005) successfully diluted sediment to estimate lethal concentrations (LC_{50}'s) of several pyrethroids. Prof. Felsot asks whether diluting sample sediment by adding uncontaminated sediment realistically represents the bioavailability of contaminants in the sample. We cannot answer this question with existing information. However, as noted as a practical consideration in Section 7, "Numeric Targets," quantifying toxic units may be unnecessary if the purpose of the analysis is only to determine if a sample is above or below the proposed targets. An undiluted sample that does not exhibit significant adverse effects when compared to control samples would meet the proposed targets. Further testing (e.g., Toxicity Identification Evaluations) would only be needed in cases of significant toxicity.

Proposed Solution to the Generic Toxicity Unit Problem

Prof. Felsot proposes a method to derive chemical-specific targets for diazinon replacements (e.g., pyrethroids). He asserts that available toxicity data (i.e., LC_{50} data) and analytical test methods are sufficient to adopt this approach, and that this approach is better than the one we propose. In essence, he proposes a target of 1 TU using the following equation:

$$TU = \frac{C_A}{LC_{50\text{-}A}} + \frac{C_B}{LC_{50\text{-}B}} + \frac{C_C}{LC_{50\text{-}C}} + \ldots + \frac{C_X}{LC_{50\text{-}X}}$$

where: C_X = concentration of pesticide X in sample
$LC_{50\text{-}X}$ = concentration of pesticide X lethal to 50% of test organisms

Despite some of the practical considerations regarding our proposed toxicity targets (see above response and Section 7, "Numeric Targets"), we prefer them to Prof. Felsot's approach for several reasons.

1. Prof. Felsot does not indicate what lethal concentration (LC_{50}) data should be used. We assume that data should represent the most sensitive species, but there is no guarantee that the species tested are the most sensitive. We could limit ourselves to species used in standard toxicity tests, but we would still have no way of knowing whether these species are sufficiently sensitive for a particular pesticide.

2. Basing the TU calculation on LC_{50}'s is not sufficiently protective. Basin Plan objectives call for no toxicity; therefore, basing targets on concentrations lethal to 50% of test organisms is inconsistent with Basin Plan objectives. We could address this by incorporating safety factors to estimate no effects concentrations. A better approach would be to use water quality criteria instead of LC_{50}'s. Unfortunately, water quality criteria exist for very few pesticides.

3. Assuming that we could estimate no effects concentrations or that water quality criteria would be available to use in the above equation's denominators, we would probably not be able to detect pyrethroid concentrations at sufficiently low levels to use the equation. Detecting environmentally relevant concentrations of pyrethroids in water is difficult, and detecting meaningful pyrethroid concentrations in sediment is also challenging (SFEP 2005). Currently, the best laboratories are able to detect most pyrethroids of interest at levels just below their lethal concentrations (Amweg et al. 2005). Therefore, we may not be able to detect the lower concentrations where chronic effects occur, much less no effects concentrations. Moreover, because the alternative target Prof. Felsot proposes combines several pyrethroids (e.g., cypermethrin, cyfluthrin, cyhalothrin, deltamethrin, and fenvalerate) into one equation, detecting even lower concentrations would be necessary. Existing analytical methods are insufficient to allow us to use this approach.

4. Prof. Felsot's approach could result in many more targets than the two toxicity targets we propose. He notes that Type I and Type II pyrethroids have two different modes of toxic action, and one needs a separate target for each group of pesticides with the same mode of action (e.g., organophosphates, carbamates, pyrethrins, Type I pyrethroids, and Type II pyrethroids). Prof. Felsot's approach would require toxicity and chemical data for a large suite of chemicals to determine whether the various targets are exceeded. In contrast, with our proposal only relatively simple toxicity tests are needed to determine whether targets are exceeded, and urban runoff management agencies already conduct these tests. Prof. Felsot's alternative approach would significantly increase the monitoring burden placed on urban runoff management agencies.

5. Prof. Felsot recommends assuming that the toxic effects of pesticides with similar modes of action are additive. However, little is known about the potential additive, synergistic (more than additive), and antagonistic (less than additive) effects of pesticides and other chemicals present in urban creeks. Our more generic approach addresses this concern. By focusing on toxicity and not individual pesticides, our approach closely relates to the Basin Plan's objectives and addresses the effects of chemical mixtures, whether additive or not.

6. Finally, Prof. Felsot's approach assumes that we know the pesticides of greatest water quality concern, now and in the foreseeable future. Unfortunately, pesticide-specific targets could be of little use as pesticide use patterns change. Our more generic toxicity targets will be useful

regardless of how the pesticide market changes in the future. If pesticide-specific targets could be useful in the future, the Water Board could consider them through adaptive implementation.

In addition to proposing pesticide-specific targets, Prof. Felsot refers to research that may call into question the ecological relevance of pyrethroids in water and sediment. As explained in Section 2, “Water Quality Conditions,” the U.S. Environmental Protection Agency’s standard toxicity tests are intended to predict ecological responses and are therefore reasonable ecological indicators. Therefore, we continue to rely on them as indicators of the ecological relevance of pyrethroids and other possible pollutants.

Total Maximum Daily Load and Allocations

Prof. Felsot acknowledges that basing the TMDL and allocations on toxicity, as proposed, is consistent with the Basin Plan objectives. He recommends the pesticide-specific approach discussed above if the TMDL is supposed to address pesticides in particular. In our view, the TMDL is intended to attain water quality standards, which in this context means attaining the narrative toxicity, sediment, and population and community ecology objectives, all of which relate to toxicity. None of these narrative objectives relate to any specific pesticide. Specific pesticide targets may be appropriate if particular pesticides are linked to toxicity, as is the case with diazinon. If so, they can be considered through adaptive implementation.

Adaptive Implementation

Prof. Felsot considers the “benchmark” factors we propose for calculating monitoring benchmarks and concludes that they are reasonable based on comparisons with factors the U.S. Environmental Protection Agency Office of Pesticide Programs uses for its ecological risk assessments. The U.S. Environmental Protection Agency incorporates factors ranging from 2 to 20, so he considers the proposed “benchmark” factors, which range from 8 to 16, to be roughly equivalent.

Prof. Felsot suggests that selecting “safety” or “benchmark” factors is a policy judgment, not a scientific judgment. While our proposal reflects our professional judgment, this judgment is informed by available information. We used the same approach that the U.S. Environmental Protection Agency used in its guidance for the Great Lakes system, which is based on an analysis of how water quality criteria relate to available toxicity data (USEPA 1991).

Overarching Questions

Prof. Felsot concludes that the proposed strategy is based on a fair assessment of available scientific data. He commends us for proposing an implementation plan that calls for partnering with many agencies and stakeholders. His main concern relates to his assertion that we could be more specific in developing our targets than relying on a generic toxicity approach (discussed above). He does not, however, question the *scientific knowledge, methods, or practices* upon which the targets are based. His remaining comment relates to the focus of proposed outreach.

Prof. Felsot notes that, as discussed in Section 6, “Source Assessment,” 4% of survey respondents admitted to improperly disposing of pesticides they do not want. He then assumes that 4% of diazinon use could have been disposed of improperly. We disagree with this assumption because the 4% of survey respondents who disposed of pesticides improperly were unlikely to have disposed of *all* their pesticides improperly (otherwise they did not "use" them at all). At any rate, Prof. Felsot concludes that inappropriate disposal could account for a large portion of pesticide runoff. He recommends focusing intently on outreach that encourages the public to dispose of pesticides properly.

We recognize the potential for illegal pesticide handling to contribute to pesticide runoff. Table 10.9 includes Action URMA-9 for urban runoff management agencies: "Facilitate appropriate pesticide waste disposal, and conduct education and outreach to promote appropriate disposal." However, we also recognize that applying pesticides in accordance with label instructions cannot be ruled out as a source of pesticides in creeks (ACCWP and ACFCWCD 1997). Our assessment of the gaps in regulatory program implementation reinforces this conclusion (see Section 4, "Regulatory Oversight"). Moreover, as shown in Table 6.1, professionals appear to apply a large fraction of the pesticides currently of concern for water quality. Due to the training and regulatory oversight that professionals receive, we doubt that they are as likely to dispose of pesticides improperly.

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